Int J Life Cycle Assess (2008) 13:512–521
DOI 10.1007/s11367-008-0023-y

LIFE CYCLE MANAGEMENT

Development of PCR for WWTP based on a case study

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Received: 13 August 2007 / Accepted: 24 June 2008 / Published online: 13 August 2008

Abstract
Background, aim, and scope In order to apply the Environmental Product Declaration (EPD) to products or services, specific rules [Product Category Rules (PCR)] have to be issued to ensure comparability among different declarations within the same service group. The aim of the present study is to describe the reasons leading to each choice in the development of PCR applied to Collecting and Treatment Service of Municipal Wastewater and to evaluate, through life cycle analysis (LCA), their influence on the potential environmental impact of a wastewater treatment plant (WWTP), analysed as a case study. Specific data were collected during the year 2003 from an Italian active sludge treatment plant with separate wastewater and sludge treatment lines.
Materials and methods The PCR 2005:5 (Collecting and treatment service of municipal wastewater (MWW). Product group/service type: refuse disposal, sanitation and similar activities, NACE code:90) document was prepared by the Department of Chemical and Process Engineering "G.B. Bonino" (University of Genoa, Italy). This PCR was tested on the Collection and Treatment Service of Municipal Wastewater in a wastewater treatment plant located in Savona, Italy (Consorzio per la Depurazione delle Acque di Scarico). The PCR 2005:5 document was issued in an open and participatory process between companies and organizations having good knowledge of the specific environmental aspects of the service to be included in the EPD® system. PCR, LCA, and EPD studies were developed according to the document "Requirements for an International EPD Scheme" (EU funded LIFE Env 2003 program, INTEND Project, www.intendproject.net).
Results The following LCA-based information was considered in preparing the PCR: definition of service type, definition of functional unit, choice and description of system boundaries, choice of cutoff criteria, choice of allocation rules, description of quality requirements for data, choice of selected LCI results or other selected parameters for description of environmental performance to be included in the declaration, description of parameters contributing to each preset category, description of specific information to be included in the use stage of the declaration, other environmental information. Ecotoxicity characterization factors, evaluated by the model Uniform System for the Evaluation of Substances (USES-LCA), was added to the PCR as an Annex. The potential environmental impacts of the considered case study were evaluated separately for the following phases: sewer net and plant construction, sewer net and plant management, sludge management. Alternative sludge management techniques were investigated.
Discussion PCR of Collecting and Treatment Service of Municipal Wastewater (MWW) was prepared in an open and participatory process between companies and organizations having in-depth knowledge of the specific environmental aspects of the service, in order to safeguard the provision and input of appropriate product-specific knowledge from relevant companies and branch organizations. The main problems characterizing the open consultation regarded are functional unit, system boundaries, boundary in time, parameters to be declared, and other information.

Responsible editor: Gerald Rebitzer

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Conclusions The annual amount of treated wastewater was considered as a functional unit. In order to evaluate water quality aspects, the request for additional information [biochemical oxygen demand (BOD)/chemical oxygen demand (COD) and nutrient removal] was added to the PCR document. These characteristics aim to complete the lack of information about wastewater quality due to the use of a fixed amount of wastewater as a functional unit. The following parameters were identified: resources use (use of nonrenewable resources, use of renewable resources, water consumption, electricity consumption), pollutant emissions as potential environmental impact (global warming, acidification, ozone depletion, photochemical oxidant formation, eutrophication), and new standard parameters (fresh aquatic ecotoxicity, fresh sediment ecotoxicity, marine aquatic ecotoxicity, marine sediment ecotoxicity). The reference model used for the calculation of toxicity potentials was the global nested multimedia fate, exposure and effects model USES-LCA. The comparison of the LCA results obtained for the considered life cycle phases shows that sewer net and plant construction have less than 10% of the total impacts for all the considered categories. Plant management has a higher impact with respect to sewer net and sludge management. In general, sludge treatment for agricultural land application has a lower impact than its treatment in landfill, but the specific results depend on the impact categories.

Recommendations and perspectives One of the most important properties of EPDs is that they provide possibilities to add up and accumulate information along the supply chain as well as to make comparisons between declarations with regard to the environmental performance of products and services. Therefore, the PCR 2005:5 document has been prepared to ensure comparability between declarations within collecting and treatment service of municipal wastewater. However, a new revised version of these rules has to be prepared according to the newly published ISO standard for EPD (ISO 14025) and to the incoming revision document of the international EPD® system.

Keywords Environmental product declaration · EPD · ISO 14025 · LCA · PCR · Product category rules · Sludge · Specific rules · Type III label · Wastewater

1 Background, aim, and scope

The European environmental policy focuses strongly on voluntary tools to be applied by private companies and public administrations for a stronger commitment to environmental protection. Systems for Type III environmental declarations (Environmental Product Declarations, EPD) are gradually becoming more known and operational on the market. This type of formalized product declaration relies on life cycle analyses (LCAs) according to ISO14040ff (ISO 2006a; Klöpffer 2005). ISO 14025 (ISO 2006b), published in 2006, describes how to develop consistent and comparable data sets (Grahl and Schmincke 2007; Schmincke and Grahl 2006), according to common rules [Product Category Rules (PCR); Fet and Skaar 2006]. PCRs ensure that results can be easily compared among products or services of the same category (Del Borghi et al. 2007).

Wastewater treatment facilities are endowed with a number of risks that may inflict some serious damage on man and his environment. Measures in common use in this respect are mostly dominated by environmental impact assessment, risk assessment, and cost-benefit analysis. LCA represents one of the newly emerging techniques with wide-ranging application in the field of wastewater treatment facilities as a decision-making tool (Tawfic 2007; Ortiza et al. 2007), in the application of cost criteria (Tsagarakis et al. 2003; Lim et al. 2007), or to select the best practicable environmental option among different technologies (Das 2002; Dennison et al. 1998).

In order to apply Type III environmental declarations to wastewater treatment services, a specific PCR has to be issued in an open and participatory process to ensure comparability among different declarations within the same service group. PCR 2005:5 on “Collecting and Treatment Service of Municipal Wastewater” was prepared by the Department of Chemical and Process Engineering “G.B. Bonino” (University of Genoa, Italy; PCR 2005:5), according to the document “Requirements for an International EPD Scheme” (2005).

The aim of the present study is to describe the reasons leading to each choice in the development of this PCR and to evaluate, through LCA, their influence on the potential environmental impact of a wastewater treatment plant (WWTP), analyzed as a case study.

2 Materials and methods

PCR 2005:5 defines the requirements, based on environmental parameters, that should be considered in an LCA and EPD study for the Collecting and Treatment Service of Municipal Wastewater (MWW).

In 2003–2004, an LCA was performed on Collection and Treatment Service of Municipal Wastewater in a wastewater treatment plant located in Savona, Italy (Consorzio per la Depurazione delle Acque di Scarico). Specific data were collected during the year 2003 from an Italian active sludge treatment plant with separate wastewater and sludge treatment lines. A commercially available software tool, Boustead Model, was used to conduct the study. The

Ecoinvent database was used when data were not available from other databases.

The PCR 2005:5 document was issued in an open and participatory process between companies and organizations having a good knowledge of the specific environmental aspects of the service to be included in the EPD® system. PCR, LCA, and EPD studies were developed according to the document "Requirements for an International EPD Scheme" (2005).

2.1 Service description

In the first draft, the PCR focused on "Collecting and Treatment Service of Municipal Wastewater" without defining the "nature" of the treated wastewater. The used term "municipal wastewater" was unclear and too broad. During the open consultation, the need to focus the study on a typical "urban flow" led to the identification of the main components constituting the municipal wastewater flow (Metcalf and Eddy Inc. 1991):

– Domestic (also called sanitary) wastewater: wastewater discharged from residences and from commercial, institutional, and similar facilities;
– Industrial wastewater: wastewater in which industrial wastes predominate (flows coming from authorized activities ad consequently "similar" to domestic ones);
– Storm water: runoff resulting from rainfall and snowmelt.

If separate sewers are used for the collection of wastewater (sanitary sewers) and storm water (storm sewers), municipal wastewater flows in sanitary sewers consist of two major components: domestic wastewater and industrial wastewater. Where only one sewer system (combined sewer) is used, municipal wastewater flows consist of three major components: domestic wastewater, storm water, and industrial wastewater.

2.2 Functional unit

With regard to the definition of the functional unit, one of the main problems to overcome during the Open Consultation was to join the quantity of treated wastewater with its quality. Two possible options were proposed:

– The product of annual average COD with average flow of wastewater ($m^3 \cdot mg/l$).
– Treatment of municipal wastewater of X households, expressed in Y inhabitant equivalents, during 1 year.

Nevertheless, a functional unit has to be easy to understand, simple to use, and equal for all EPDs in this product category to ensure the possibility to compare them.

According to these principles, a fixed amount of wastewater was chosen as a functional unit. In order to evaluate water quality aspects, the request for additional information [biochemical oxygen demand (BOD)/chemical oxygen demand (COD) and nutrient removal] was added to the PCR document (chapter 2.6 "Other Information").

2.3 System boundaries

According to the Requirements for an International EPD Scheme (2005), the life-cycle phases are defined as:

– Production phase: preparation of the service and hence purchasing of goods and materials necessary to make it ready;
– Use phase: service supply;
– End-of-life phase: service ending or completion.

The production phase included sewer net and treatment plant construction (use of structural concrete, pipe bedding concrete, steel pipes, pig iron pipes, etc.). The Use Phase represents service supply and includes wastewater collection and treatment, sludge production and management, biogas production and management (in case of sludge treatment by anaerobic digestion). Both sludge transport to external treatment plants and sludge management are included in the system boundaries. The sludge management includes both on-site and external treatment. Due to the difficulty in assuming complete disposal of the wastewater treatment plant after its lifetime, the End of Life Phase was excluded by the system boundaries. Lifetime information of the plant was inserted in chapter 2.6 "Other Information". The results of the study confirm that the End of Life Phase contributes only to waste production.

The life cycle boundaries for MWW are described in the flowchart of Fig. 1.

2.3.1 Boundary in time

About boundary in time, a time period of 1 year was chosen for the evaluation of the environmental impacts due to the Use Phase. In fact, a suitable time period has to be defined for the collection of those specific data which characterize wastewater and sludge management operations. The boundary in time of the Production Phase was the whole lifetime of the plant (Lundin and Morrison 2002). A period of 30 years was considered in the case study.

2.3.2 Boundaries towards nature

The boundaries towards nature shall describe the flow of material and energy resources from nature into the system and emissions from the system to air and water and waste.

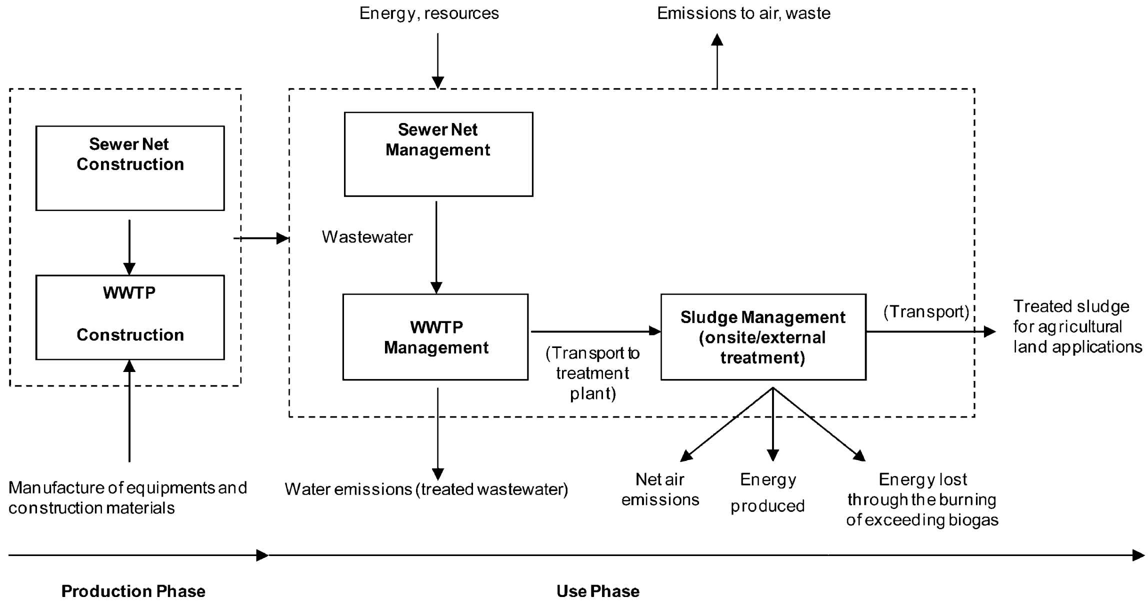


Fig. 1 System boundaries

Analyzing a wastewater treatment plant, the flow of material and energy resources from nature into the system would be represented by:

- Energy and resource consumption for treatment plant and sewer net construction;
- Energy and resource consumption for wastewater and sludge treatment;

While the emissions from the system to air, water, and waste will be represented by:

- Emissions related to sewer net management (i.e., untreated wastewater drained to rivers/sea owing to failures or maintenance operations etc.);
- Emissions related to wastewater treatment (i.e., treated wastewater drained to rivers/sea, air emission from deodorizers, waste production, etc.);
- Emissions related to sludge treatment (air emissions from deodorizers, air emissions from biogas combustion, etc.).

2.3.3 Boundaries toward other technical systems

The boundaries toward other technical systems describe the inflow of material and components from other systems and the outflow of material to other systems.

If there is an inflow of recycled material to the product system in the production/manufacturing phase, the recycling process and the transportation from the recycling process to where the material is used shall be included. If there is an outflow of material to recycling, the transportation to the recycling process shall be included. The material going to recycling is then an outflow from the product system.

In the PCR for MWW, the main outflow of material to other technical systems is represented by the sludge going to treatment in external plants, if treatment on-site is not carried out. Following up some remarks, also treated sludge transport to its final destination was included in the LCA analysis.

2.4 Allocation rules

The allocation problem consists of the need to correctly split the environmental pressures among the studied system and the other interacting ones. In a wastewater treatment plant, the allocation problem mainly concerns sludge treatment, when sludge is treated in external plants together with other waste (i.e., incineration or disposal in landfill with municipal solid waste). Whenever it was necessary to partition the system inputs and outputs, mass criteria would be used. The possibility of applying economic allocation criteria is excluded because of its sensitivity to market specific conditions.

2.5 Parameters to be declared in the EPD

According to the reference document “Requirements for an International EPD Scheme” (2005), the following parameters were identified: resources use (use of nonrenewable resources, use of renewable resources, water consumption, electricity consumption), pollutant emissions as potential environmental impact (global warming, GWP; acidification, AP; ozone depletion, ODP; photochemical oxidant formation, POCP; eutrophication, EP). Global warming from renewable sources (kg $CO_{2biol.}$equivalents)

was also considered. In addition to the identified standard parameters, the following new ones were added:

- Fresh aquatic ecotoxicity (FAETP) kg 1,4 DCB (1,4 dichloro-benzene) equivalents
- Fresh sediment ecotoxicity (FSETP) kg 1,4 DCB (1,4 dichloro-benzene) equivalents
- Marine aquatic ecotoxicity (MAETP) kg 1,4 DCB (1,4 dichloro-benzene) equivalents
- Marine sediment ecotoxicity (MSETP) kg 1,4 DCB (1,4 dichloro-benzene) equivalents

Toxicity potentials are standard values used in life LCA to enable a comparison to be made of toxic impacts between substances.

The Apeldoorn Workshop (April 15th, 2004, Apeldoorn, NL) brought together specialists in LCA and Risk Assessment to discuss current practices and complications of the life cycle impact assessment (LCIA) ecological toxicity (ecotox) methodologies for metals. The consensus was that the LCIA methods currently available did not appropriately characterize impacts of metals due to lack of fundamental metal chemistry in the models.

The open consultation highlighted the necessity to thoroughly analyze the problems related to the ecotoxicity theme, in particular, to carry out a further validation. It was advised to:

1. find a pragmatic solution for the inconsistent results concerning the heavy metals;
2. calculate the various ecotoxicity themes without overestimating their accuracy and relevance;
3. perform an additional analysis to address local impacts, for instance an Environmental Risk Assessment.

In order to meet these requirements, the reference model used for the calculation of toxicity potentials was the global nested multimedia fate, exposure, and effects model Uniform System for the Evaluation of Substances (USES-LCA). It is based on USES 2.0. USES-LCA was used for the calculation of 181 substances toxicity potentials for the six impact categories (freshwater aquatic ecotoxicity, marine aquatic ecotoxicity, freshwater sediment ecotoxicity, marine sediment ecotoxicity, terrestrial ecotoxicity, and human toxicity) after initial emission to the compartments air, freshwater, seawater, industrial soil, and agricultural soil, respectively (Huijbregts et al. 2000; Del Borghi et al. 2005). Gloria et al. (2006) illustrates the need to proceed with caution when applying LCIA ecotox methodologies to life cycle studies that include metals.

In order to ensure uniformity among different EPDs in the use of characterization factors related to ecotoxicity, a list of the related characterization factors was enclosed in the PCR document.

2.6 Other information

Additional information can be divided into two main groups: mandatory required information and optional information. Mandatory required information includes process characteristics of wastewater treatment plant and additional parameters and information relevant to describe the environmental performance of the product category (BOD/COD removal, nutrient removal, visual impact, odors). These characteristics aim to complete the lack of information about wastewater quality due to the use of a fixed amount of wastewater as a functional unit (1 m^3).

3 Results

The potential environmental impact of a wastewater treatment plant was analyzed as a case study. Specific data were collected during the year 2003 from an Italian active sludge treatment plant with separate wastewater and sludge treatment lines.

The potential environmental impacts of the considered case study were evaluated separately for the following phases: sewer net and plant construction, sewer net and plant management, sludge management. Alternative sludge management techniques were investigated (Suh and Rousseaux 2002).

Tables 1 and 2 show nonrenewable and renewable resource use, water consumption, and the potential environmental impacts for the treatment of 1 m^3 of wastewater.

Concerning nonrenewable resource without energy content, the Production Phase has the highest contribution (94%) due to the consumption of raw materials in sewer net and plant construction.

The electricity consumption during the Use Phase causes consumption of resource with energy content for the sewer net and WWTP management (90% of the total consumption).

Concerning pollutant emissions (see Table 2), the comparison of the LCA results obtained for the considered life cycle phases shows that sewer net and plant construction have less than 10% of the total impacts for many of the considered categories. Eighty-five percent of waste is due to sewer net construction.

In the Use Phase, WWTP and Sewer Net Management have comparable impacts with the exception of EP and ecotoxicity potentials, due to the significant water emissions during management of the WWTP.

For this case study, only marine ecotoxicity potentials are considered due to the plant location.

Sludge management has a low impact in all the considered categories.

Table 1 Resource use

Resource use	Production phase		Use phase			Total
	Sewer Net construction	WWTP construction	Sewer Net management	WWTP management	Sludge management	
Nonrenewable resource without energy content	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3
Sodium chloride	0.001	0.011	<0.001	48.085	0.026	48.124
Calcium sulfate	3.083	1.823	<0.001	<0.001	0.002	4.908
Iron	9.314	0.821	0.017	0.023	0.479	10.654
Limestone	80.983	46.878	0.004	0.644	0.922	129.431
Sand	178.456	78.080	<0.001	0.002	0.006	256.544
Gravel	339.444	145.841	<0.001	<0.001	0.998	486.284
Shale	8.727	5.161	<0.001	<0.001	0.006	13.894
Potassium Chloride	<0.001	<0.001	<0.001	1.744	<0.001	1.744
Other	0.406	0.813	0.003	3.145	0.146	4.512
Total	620.414	279.429	0.024	53.643	2.585	956.095
Non-renewable resource with energy content	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3
Coal	0.498	0.229	0.531	0.777	0.022	2.059
Oil	0.092	0.043	2.308	2.538	0.524	5.505
Gas	0.071	0.039	1.069	1.381	0.280	2.840
Nuclear	0.062	0.034	0.511	0.732	0.013	1.354
Sulfur	<0.001	<0.001	<0.001	0.001	<0.001	0.001
Hydrogen	<0.001	<0.001	<0.001	0.012	<0.001	0.012
Peat	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lignite	<0.001	<0.001	0.022	0.073	<0.001	0.095
Total	0.723	0.346	4.459	5.532	0.840	11.90
Renewable resource with energy content	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3	MJ/m^3
Hydroelectric	0.002	0.005	0.449	0.500	0.008	0.963
Wood	<0.001	<0.001	<0.001	0.002	<0.001	0.002
Biomass	<0.001	<0.001	0.012	0.016	<0.001	0.028
Geothermic	<0.001	<0.001	0.024	0.024	<0.001	0.048
Solar	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Wave/tidal	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total	0.002	0.005	0.485	0.542	0.008	1.0427
Total water consumption kg/m^3	1.694	0.721	0.133	4.916	0.354	7.818

Alternative sludge management techniques were investigated comparing sludge treatment for agricultural land application and its disposal in the landfill. Results are referred to the treatment of 1 ton of sludge. Energy results are expressed by the so-called gross energy requirement (GER), defined as the amount of energy source which is sequestered by the process of making a good or service. The specific results depend on the impact categories (Fig. 2).

Table 2 Pollutant emissions

Category of impact	Unit	Production phase		Use phase			Total
		Sewer net construction	WWTP construction	Sewer net management	WWTP management	Sludge management	
GWP100	kg CO_2/m^3	0.10	0.05	0.27	0.34	0.06	0.82
AP	mol H^+ /m^3	0.83	0.45	5.78	6.71	0.87	14.65
POCP	kg C_2H_4/m^3	0.01	0.01	0.71	0.74	0.07	1.53
EP	kg O_2/m^3	1.33	0.72	13.42	165.97	3.09	317.64
ODP	kg CFC11/m^3	0	1.0×10^{-8}	0	3.8×10^{-7}	1.0×10^{-8}	4.0×10^{-7}
MAETP	kg 1,4DCB/m^3	1.80	1.80	1.80	11,664.35	1.92	11,599.91
MSETP	kg 1,4DCB/m^3	1.90	1.90	1.90	11,472.78	2.02	11,406.39
Hazardous waste	kg/m^3	–	–	–	0.00013	–	0.00013
Other waste	kg/m^3	0.3003	0.0173	0.0051	0.0287	0.0009	0.3523

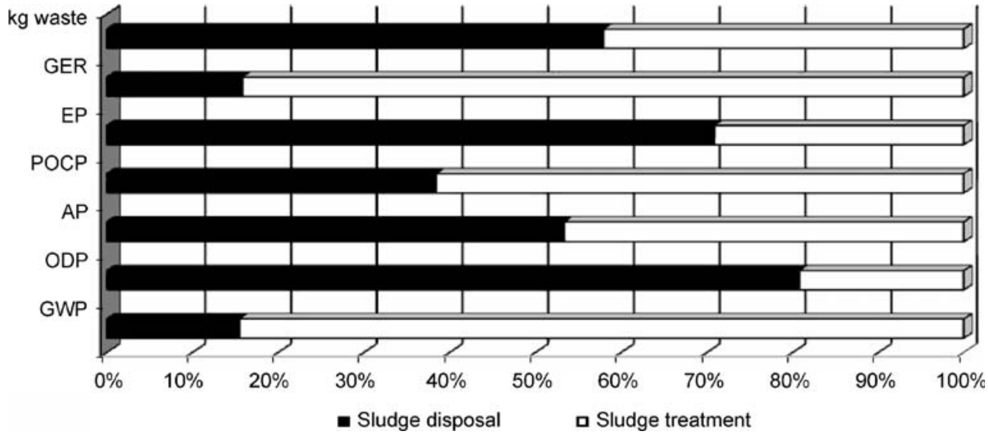


Fig. 2 Comparison of different sludge management options

Sludge disposal in the landfill yields a higher contribution to the environmental load, for EP and ODP, if compared with sludge treatment. At the same time, it is comparable to sludge treatment with regard to waste production, POCP, and AP, whereas it shows a lower contribution for GER and GWP. The higher impact of sludge treatment is mainly due to the CO_2 and SO_x emissions and energy consumption for sludge depuration and transport to agricultural lands.

When the purpose of the study is to compare different waste management options, to assess the complete picture of the burdens and benefits arising from recycling, the system boundaries can be expanded to include recycling loops (Nyland et al. 2003). By expanding system boundaries including the energy production by sludge disposal in landfill and the use of treated sludge as agricultural fertilizer, the results show that the impacts of treating sludge to GWP and GER are completely covered by the avoided burdens of producing fertilizers (Fig. 3).

A sensitivity analysis was performed in order to evaluate the variation of the potential environmental impacts with the most significant input parameters: electricity consumption, sludge production, and NaClO consumption. These parameters were varied across a range of values near the LCI value and the effect on the main impact categories observed. The obtained results (Fig. 4) show that a slight variation of these parameters causes a significant impact increase. In particular, variations on electricity consumption can affect POCP, GWP, and AP.

4 Discussion

The main issue presented in this paper is the development of the PCR document on “Collecting and Treatment Service of Municipal Wastewater” (PCR 2005:5). The main problems characterizing the Open Consultation regarded: functional unit, system boundaries, boundary in time, parameters to be declared, other information.

A wide-ranging discussion regarding each topic was put in paragraph 1 Method.

The chosen functional unit is the treatment of 1 m^3 of wastewater. System Boundaries were defined according to the Requirements for an International EPD Scheme (2005). The results of the study confirm that the End of Life Phase can be excluded by the system boundaries. Moreover, a comparison of the case study results shows that sewer net and plant construction have less than 10% of the total impacts for all the considered categories. Plant management has a higher impact with respect to sewer net and sludge management. In general, sludge treatment for agricultural land application has a lower impact than its treatment in the landfill, but the specific results depend on the impact categories. The sensitivity analysis shows that electricity consumption represents the most significant parameter.

Other authors excluded from the system boundaries the collection and transportation of wastewater across the pipeline as well as the “building phase” (Hospido et al. 2008). Instead, the obtained results show that these phases could have significant impacts concerning resource consumption and pollutant emissions.

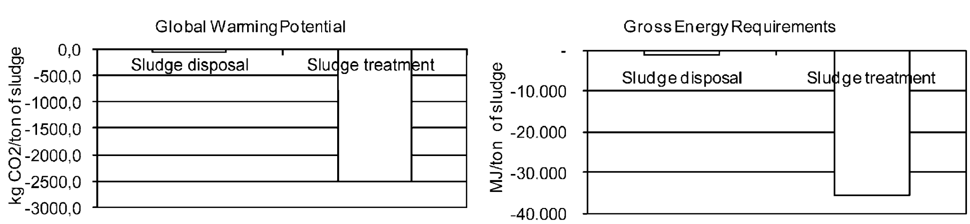
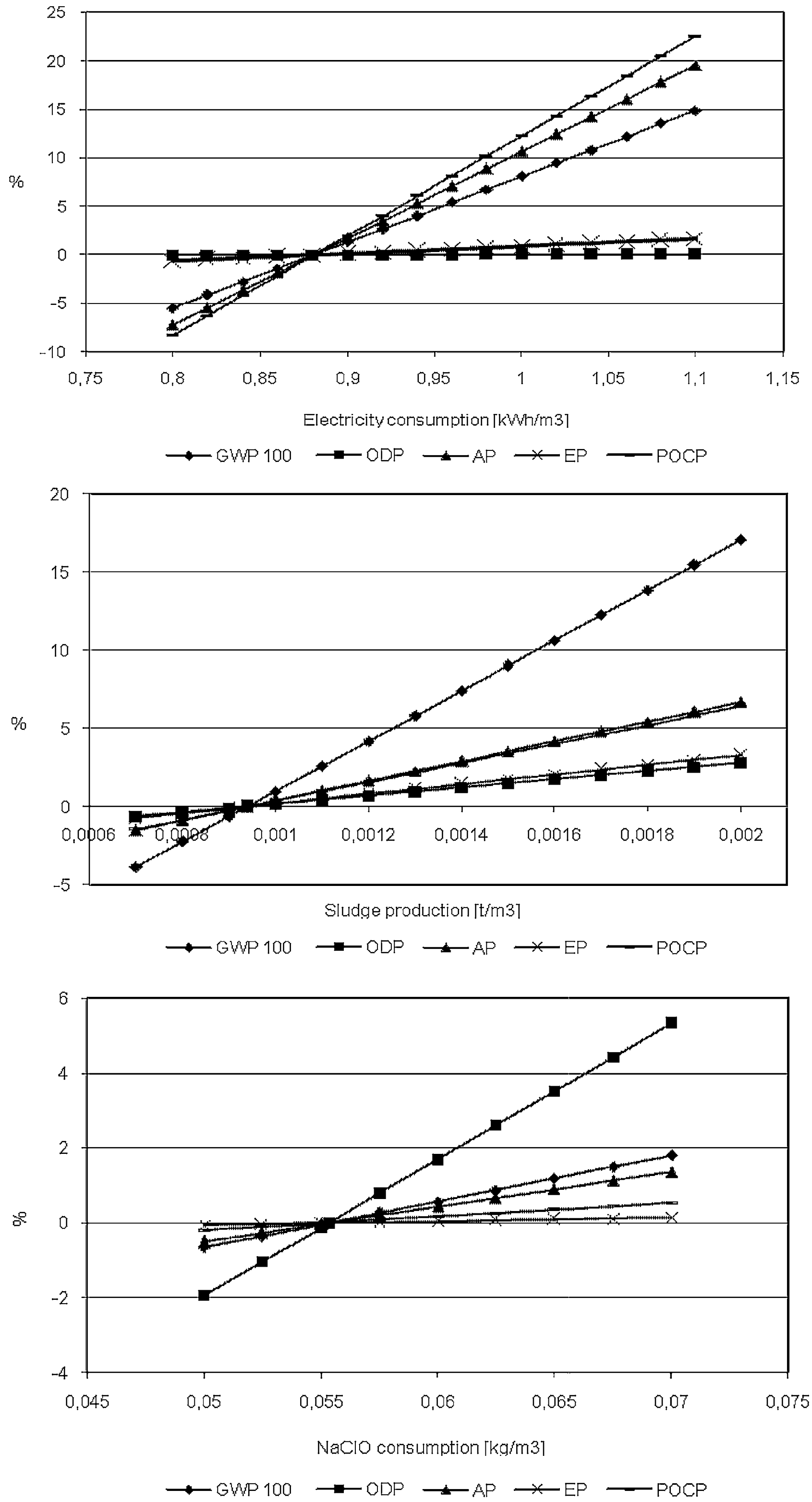


Fig. 3 Comparison of different sludge management options expanding system boundaries

Fig. 4 Sensitivity analysis



Toxicity potentials were calculated using the global nested multimedia fate, exposure, and effects model USES-LCA. Since LCIA methods currently available do not appropriately characterize impacts of metals due to lack of fundamental metal chemistry in the models, the deficiencies should be clearly communicated as part of the EPD.

5 Conclusions

The present paper shows the application of LCA to a wastewater treatment plant (WWTP), analyzed as a case study in order to develop the PCR of MWW. The intent of this PCR is to provide the basis for a fair comparison of Wastewater Treatment services through their environmental performance, to provide a tool for the realization of verifiable and accurate LCA and EPD studies and indirectly to encourage the demand for those services that cause less stress on the environment-stimulating continuous environmental improvement. The LCA results presented in this paper could be published as an EPD for the case study, according to the PCR 2005:5. In the municipal wastewater sector, EPD could be used as a source of information by municipalities, local corporations, and industrial consumers, making it possible to provide easily accessible, quality assured, and comparable information regarding environmental performance of these kinds of service. Moreover, the comparison of the LCA results obtained along the supply chain of the service and for the alternative sludge treatment methods in the investigated case study shows that an LCA for an EPD could be used as a tool for process selection and environmental improvement.

In conclusion, the life-cycle approach applied to the wastewater treatment plants shows that LCA represents an environmental management tool able both to communicate environmental information by the Type III environmental label EPD, and to look for different scenarios that can improve the environmental performance of the “Collecting and Treatment Service of Municipal Wastewater”.

6 Recommendations and perspectives

The newly published ISO standard for EPD (ISO 14025) and experience gained from the EU-project “Requirements for an international EPD scheme” (the Intend project) call for a revision toward a so-called International EPD® system (Programme Instructions for the International EPD® system 2008). As EPDs from different programs may not be comparable, ISO 14025 recommends that program operators facilitate harmonization when developing programs and the PCR. In order to establish a market-accepted, pragmatic, and transparent procedure to identify and define product categories in a useful PCR structure, the international EPD® system introduces the following innovations to facilitate international participation in PCR work: the so-called PCR module initiative (PMI), a PCR moderator, and the Global PCR Forum.

Concerning system boundaries, the international EPD® system has adopted an LCA calculation procedure which is separated into different life cycle stages:

- upstream processes (from cradle-to-gate);
- manufacturing processes, also referred to as the “core module” (from gate-to-gate);
- downstream processes (from gate-to grave).

As a consequence of these considerations, PCR 2005:5 may need to be revised in order to fulfill the requirements of ISO 14025 and the international EPD® system. The system boundaries should guarantee the modularity principle: the “production of the service” might be regarded as the “core module” instead of the manufacturing processes. The more pronounced difference between goods and services with regard to the PCR work is most likely the relatively distinct focus on defining the responsibilities of the service provider in their use of products, which they, to some extent, have management control over.

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